ena. The decay of the primal and auroral strata of the Appalachian valley, and the formation therein of clays and of iron and manganese oxides, was also discussed. The pre-Cambrian antiquity of the process of decay in the eozoic rocks of the Mississippi valley, as shown by Pumpelly and by Irving, as well as similar evidence from Europe, was noted, while the more recent decomposition seen in the auriferous gravels of California was described and explained.

The final removal of the covering of decayed rock from many northern regions during the drift period was then considered; and the thesis advanced by the speaker in 1873, that the decay of rocks "is an indispensable preliminary to glacial and erosive action, which removed previously softened materials," was discussed in its relations to bowlders, glacial drift, and the contour of glaciated regions. Pumpelly's development and extension of this doctrine to wind-erosion was noticed, and also the recent comparative studies of Reusch in Norway and in Corsica, in which similar views are enforced.

The principal points in the paper, as reviewed at its close, are as follows: —

1. The evidence afforded by recent geological studies in America and elsewhere, of the universality and the antiquity of the subaerial decay, both of crystalline silicated rocks and of calcareous rocks, and of its great extent in pre-Cambrian times.

2. The fact that the materials resulting from such decay are preserved *in situ*, in regions where they have been protected from denudation by overlying strata, alike of Cambrian and of more recent periods; or, in the absence of these, by the position of the decayed rock with reference to denuding agents, as in driftless regions, or in places sheltered from erosion, as within the St. Lawrence and Appalachian valleys.

3. That this process of decay, though continuous through later geological ages, has, under ordinary conditions, been insignificant in amount since the glacial period, for the reason that the time which has since elapsed is small when compared with previous periods; and also, probably, on account of changed atmospheric conditions in the later time.

4. That this process of decay has furnished the material, not only for the clays, sands, and iron oxides from the beginning of paleozoic time to the present, but also for the corresponding rocks of eozoic time, which have been formed from the older rocks by the more or less complete loss of protoxide bases. The bases thus separated from crystalline silicated rocks have been the source, directly or indirectly, of all limestones and carbonated rocks, and have, moreover, caused profound secular changes in the composition of the ocean's water. The decomposition of sulphuretted ores in the eozoic rocks has given rise to oxidized iron ores *in situ*, and to rich copper deposits in various geological periods.

5. That the rounded masses of crystalline rocks, left in the process of decay, constitute not only the bowlders of the drift, but, judging from analogy, the similar masses in conglomerates of various ages, going back to eozoic times; and that not only the forms of such detached masses, but the surface-outlines of eroded regions of crystalline rocks, were determined by the preceding process of subaerial decay of these rocks.

THE ORIGIN OF CROSS-VALLEYS.

I.

DR. FR. LÖWL of Prague contributes an interesting article on *Die Entstehung der Durchbruchsthäler* to a recent number of *Petermann's mittheilungen* (1882, 405–416), and comes to the conclusion that transverse valleys or water-gaps are never formed by the persevering action of an antecedent or pre-existing river on a slowly rising mountain fold or fault. "Erosion can, under no circumstances, keep pace with mountain folding" (409). Cross-valleys are then accounted for in two other ways, — first, occasionally by erosion at the outlet or point of overflow of the lake formed behind the rising mountain barrier; second, and so frequently as to constitute the general method, by backward erosion at the head of a lateral valley, which finally cuts through the ridge separating two longitudinal valleys, and allows the higher to drain across into the lower, so that in a folded mountain system of great age the original order of drainage on the longitudinal valleys is often entirely effaced (411). Several carefully examined cases of this kind are described for the eastern Alps and elsewhere. The question does not arise now whether these examples are correctly determined: presumably those to which sufficient local study was given are decided safely enough; for this backward origin of certain gorges is eminently possible. The question is rather, whether nearly all cross-valleys are of this ancestry, and whether the antecedent valley nowhere exists. We consider Löwl's affirmative answer to this question essentially incorrect, and believe that his

error of result comes from an error of method of but too prevalent a kind; namely, the assumption that things of a single geographic name are to be accounted for by a single physical or geological cause. Geographical nomenclature is in no condition to allow such an assumption; for no science has so loose, inaccurate, and insufficient a terminology as geography. Not a few examples could be given of errors arising from this *one-name, one-cause* idea. Until it is proved that two phenomena are closely alike in their several characters, an explanation of the origin of one will not necessarily apply to the other; and for this reason, in our present ignorance of the structure and form of many regions otherwise comparatively well known, it is not safe to extend local explanations over too broad a field.

Löwl rejects the possibility of a river's holding its course across a rising mountain fold; because the several examples discussed in his paper, chiefly those rivers on the northern slope of the Alps which are temporarily warped into lakes, have failed in doing so (408, 409). To this it might be answered, that these lakes are perhaps formed by a local depression of the valley-way, rather than by a local uplift at their outlets, and, moreover, that they constitute such an 'ephemeral phase in the river's history' as hardly to constitute a serious argument toward a decision. The temporary formation of a lake behind the growing fold, afterward drained by the victory of the river, is not sufficient ground for excluding the valley from the antecedent species, though it might serve for the marking of a variety. But even admitting the correctness of this conclusion for the Swiss rivers, it proves nothing for the rivers that escape from other mountain ranges. The success of the river depends on the proper relation of two variable factors, — the rate of its erosion, and the rate of the mountain's growth; and these may have such different relative values, — as determined by rainfall, drainage area, altitude, distance to the sea, mountain-making force, composition and attitude of the rocks, — that the predetermination of the result is impossible. Nothing short of close local study will serve to answer the question with any approach to certainty; and it therefore seems best to trust the Indian surveyors in their explanation of the Sutlej[1] gorge, and our own geologists in their reports on the rivers they have examined in the western territories. Concentrated erosion can keep pace with mountain folding, and antecedent valleys are often preserved.

Reference is made to the several transverse valleys of the Delaware, Potomac, and Susquehanna in the Appalachians (407), with the conclusion that they cannot be explained as antecedent valleys.[1] In spite of the many observers devoted to the study of the Appalachians in the past fifty years, there is yet no good topographic map of any large part of them, and much remains to be done in explaining their geological structure. It is still rather early to write their history; but we do not believe that the objections raised by Löwl to the antecedent character of their larger valleys are conclusive. The theory of these valleys, so far as it can be now stated, should, of course, be led by the facts so far as they are now known; and, in the writer's mind, the facts lead directly to the theory that the valleys are antecedent. The question is made clearer if we consider first the case of the rivers in Tennessee and south-western Virginia that rise in the archaean mountains of North Carolina, — the Great Kanawha and the Tennessee. The first of these follows the direction of slope that must have prevailed through all paleozoic time, in running from the old crystalline mountains, north-westerly, across the strata derived from their waste. We must conclude that the growth of the great post-carboniferous folds and faults on its course were insufficient to turn it into a north-eastward or south-westward channel. It flows along a true antecedent valley; and our notions of the rates of mountain growth and river erosion should conform to the fact of its existence. The Tennessee also finally makes its way to the north-west; but none of its branches that rise in the North Carolina mountains succeeded in crossing all the folds and faults that grew in front of them. Although they all made their way through some of these barriers, they were sometimes turned to the south-west; and not until they were united in great volume could they escape to the north-west at Chattanooga, and again at Claysville, Ala. This shows a river greatly embarrassed by the difficulties that arose in its way. Most of its branches failed, and were turned aside into consequent longitudinal valleys; but some suc-

[1] Hardly recognizable in its modern Germanized form, *Satladsch*. The German transliteration of the valuable English consonant, j, is very cumbersome. Witness *Udschidschi*.

[1] Löwl does not detect a misquotation by Tietze, whose valuable *Bemerkungen über die bildung von querthälern* (*Jahrb. geol. reichsanst.* 1878, 581-610) he endeavors to controvert. Tietze states (600), that, according to Dana, the Appalachians grew by addition of parallel folds on the eastern or seaward side. Löwl quotes Credner to prove the opposite order of growth, but Dana also said just the reverse. See *Amer. journ. sc.*, iii. 1847, 183.

ceeded, and these survive in the existent water-gaps. There can be little doubt that lakes very frequently appeared and disappeared on these stream-courses during the growth of the mountains.

THE INTELLIGENCE OF FISH.

IN Mr. Romanes's recent volume on Animal intelligence,[1] only thirteen pages are devoted to the intelligence of fish. That this class of animals is more 'knowing' than is generally believed, is, I hold, unquestionable. From frequent conversations with old fishermen, I have learned that the exercise of cunning, on the part of fish, is by no means uncommon; and I have also found that certain sayings are common among these people, such as 'cute as an eel,' 'sly as a snippick,' i.e., snipe-pike (Belone truncata), which also show that fish are credited with considerable intelligence by these practical observers, whether rightfully or not. My own impression, based upon long-continued, careful study of our fish, long since fully convinced me that many of them were possessed of nearly as much intelligence as birds, and more than either the snakes or batrachians. This may seem a hasty statement, but I believe it is substantially correct. For this reason, I am surprised that so little has been recorded by observers, with reference to fish, as is evident from the meagre array of facts presented by Mr. Romanes in the work mentioned. The author, in the opening remarks of his chapter on fish, says, "Neither in its instincts nor in general intelligence can any fish be compared with an ant or a bee." This statement I propose to dispute, because there is abundant evidence that the intelligence of fish varies exceedingly, and some fish do possess an amount of cunning which brings them nearer to the ants or bees than Mr. Romanes's remark would imply. Had our author said 'most fish,' perhaps no exception could have been taken to the statement; but, using the words 'any fish,' he is, I think, open to criticism.

But what are the evidences that some fish possess such an amount of intelligence as I have intimated? In reply, I have to offer a case of great cunning shown by a number of pike when in danger of capture. A gilling-net had been placed across the outlet of a small tributary of Popihacka Creek. In this little spring-brook several large pike had wandered in search of minnows. Being disturbed, they rushed with great impetuosity towards the net, and the foremost of them was at once securely entangled in its meshes. Straightway the others stopped as suddenly as they had started, and, recognizing their fellow in trouble, 'took in the situation' at once. Each pike evidently realized the true condition of affairs, and reasoned thus: that pike tried to go through this obstacle in the water, and is in trouble; it is necessary for me to avoid it by some other means. There were five of these fish that paused close to the net; and each acted, I believe, as it *thought* best. One of them came to the surface, and, after a moment's pause, turned upon one side, and leaped over the cork-line. Seeing the success of this effort on the part of one, a second did the same. A third came to the shore near where I stood, and, discovering a narrow space between the brail and the net, passed very slowly through, as though feeling its way, although the water was so shallow that its body was fully one-third out of the water as it did so. The others were either more timid or less cunning. They turned to go up stream; but being met by my companion, who was making a great noise by whipping the water, they rushed again towards the net, but checked their course when their noses touched the fatal net. Prompt action was necessary. They had not confidence in their leaping-powers; and both, as though struck with the same thought at the same moment, sank suddenly to the bottom of the stream, and burrowed into the sand and beneath the lead line, which was in full view. In a moment they reappeared on the other side of the net, and were gone. I could have prevented the escape of all of these fish, but was so much interested in the evidence of thought exhibited by them, that the idea of molesting them did not occur to me. There was something in the manner of these fish, too, which is not readily described, but which gave an importance to those acts, on their parts, that I have mentioned, and which added materially to the strength of the evidence that they were 'thinking' in all that they did.

Evidence of the intelligence of fish is further shown by our common sunfish (Eupomotis aureus), which not only mates early in the spring, and guards its nest and young until the latter are able to shift for themselves, but in many cases remains paired. If it can be said of storks, that marriage occurs among them, the same is true of sunfish. I have known the same pair to occupy for several years the well-protected space bounded by the twisted roots of an enormous maple, that

[1] Animal intelligence. By George J. Romanes. — (*Internat. sc. ser.*, no. xliv.) New York, *Appleton & Co.*